



More Knowledge, Less Intention? The Moderating Role of Subjective Health Knowledge and Education Level within a TPB Model in Physical Activity Intentions among Chronic Patients

Yuxuan Wu^(✉)

Shandong University, Jinan 250100, China
yxwww627@163.com

Abstract. A high percentage of people with chronic diseases do not experience adequate physical activity. The purpose of this study is to explore the factors regulating physical activity based on the theory of planned behavior (TPB). Additionally, we incorporated subjective health knowledge and education level with the TPB theoretical framework to act as moderators. Data were collected from 639 individuals with chronic diseases in our survey. Results revealed that subjective norms and perceived behavioral control were statistically significant predictors of physical activity intentions, with the perceived behavioral control having the strongest effect on the intention to partake in physical activity. Attitude had no significant effect. Subjective health knowledge negatively moderated the relationship between perceived behavioral control and intention, while education level negatively moderated the relationship of subjective norms-intention among people with chronic diseases in this study. The results provide guidance to doctors and health practitioners to develop interventions tailored to assisting chronic patients with different levels of subjective health knowledge and education, thus requiring the medical professionals to consider health education carefully.

Keywords: Theory of planned behavior · Subjective knowledge · Education level · Physical activity

1 Introduction

Chronic diseases lead to 41 million deaths each year and are thus the principal recipe for global mortality, accounting for most causes of premature death and disability worldwide [1]. The status of chronic diseases does not bode well in China either. More than one-fifth of the population has chronic diseases, which give rise to almost ninety percent of all deaths in China, while the medical burden of chronic diseases accounted for about seventy percent of the whole [2]. Chronic diseases not only jeopardize people's health but also exert an adverse impact on the social economy.

There is a growing consensus that physical activity is one of the best ways to decrease the risk of chronic diseases and enhance health. Numerous previous studies have examined the effect of physical activity on chronic diseases, pointing out that physical activity can provide a noninvasive means of adding to the prevention and treatment of chronic diseases [3]. Nonetheless, more than three-fifths of Chinese people live without taking part in regular physical activity [4]. Hence, it is imperative to encourage participation in physical activity in China.

To investigate effective ways to promote engagement in physical activity for people with chronic diseases, we first need to understand which factors influence individuals to practice a given behavior. Several previous psychological and psychiatric theories are valid means of interpreting factors that predispose people to engage in physical activity. One of these, the theory of planned behavior (TPB), includes three key independent variables—attitude, subjective norms, and perceived behavioral control—and is one of the theoretical frameworks that considers behavioral intention as the proxy of the actual behavior [5]. TPB is extensively utilized in studies of the participation of people with chronic diseases in physical activity. For instance, a previous study indicated that all TPB constructs are predictors of physical activity in type 2 diabetic patients [6]. Goldoust et al. also found that all constructs of TPB could predict the behavioral intention of physical activity among women with multiple sclerosis [7]. These studies showed the rationality of applying TPB when investigating the factors governing physical activity.

Subjective health knowledge is related to people's awareness of physical activity, which may contribute to modest enhancements in physical activity for people with chronic diseases. O'Halloran et al. included subjective health knowledge as a moderator within the TPB model, which positively moderated the attitude-intention relationship while negatively moderating subjective norms-intention and perceived behavioral control (PBC)-intention relationships [8]. Subjective health knowledge is one of the factors regulating physical activity, so it is reasonable to consider it as a moderator in this study.

Education level reflects an individual's universal knowledge level, which guides personal values that direct people toward perceptions and solutions. A study pointed out that people with a higher education level were more likely to show behaviors that were compatible with social practice [9]. Previous studies have indicated the moderating effect of education level in various conditions, which included the utility of mobile apps, product purchase, health behaviors, and so forth, verifying the moderating effect of education level within the theoretical framework of TPB [10–12]. In this study, we introduced education level as a moderator within TPB in the context of physical activity among chronically ill patients.

This study aimed to examine the relationship between attitude, subjective norms, perceived behavioral control, and the intention to maintain physical activity among people with chronic diseases, by investigating the moderating role of subjective health knowledge and education level. Against this backdrop, a conceptual model was proposed based on an extension of the theory of planned behavior, which incorporates subjective health knowledge and education level with TPB as the moderators.

2 Literature Review

2.1 Theory of Planned Behavior

TPB is a theoretical framework to explore the underpinnings of volitional behavior, which assumes that behavioral intention is the determining factor of behavior and includes three antecedents: attitude, subjective norms, and perceived behavioral control [13]. TPB is extensively utilized in predicting the engagement of physical activity in different health conditions, such as adults with physical disabilities and cancer survivors, as well as chronic diseases [14–18].

Attitude refers to an individual's positive or negative view of behavior [19]. Generally, if the behavioral outcome is considered to be positive, the individual's attitude will be positive and they will be more likely to perform the behavior. Chevance et al. found that obese participants with habitual sedentary behavior held a more positive attitude to physical activity and performed at a higher objective level of physical activity [20]. A study suggested that attitude was significantly related to physical activity among women with hypertension in rural areas of Iran [21]. A recent study integrating self-determination theory into the research model demonstrated that attitude toward physical activity was a strong predictor of physical activity intention among college students in central China [22]. These studies showing the association between attitude and the intention or actual practice of physical activity in various regions and with distinct health conditions established the rationality of attitude in predicting the intention to practice physical activity among people with chronic diseases.

Subjective norms refer to an individual's perception of how important others view their behavior, thus influencing people's behavioral intentions [5]. Individuals will perceive social pressure from engaging or not in a given behavior and the tendency of subjective norms will direct their adaptation to this pressure [23]. Recently, a study reviewed norms in physical activity and indicated that subjective norms are one of the most conceptualized norms used in physical activity, which showed that subjective norms can indeed predict one's intentions regarding physical activity [24]. A previous study indicated that a subjective norm is an applicable predictor of physical activity in American and Canadian contexts [25]. Úbeda-Colomer et al. integrated social-ecological barriers within a TPB theoretical framework, which suggested that subjective norms toward physical activity played an important role in predicting the intention to practice physical activity among university students with disabilities in Spain [26]. These pieces of evidence show that it is reasonable to utilize subjective norms as a predictive factor of the intention to be physically active.

Perceived behavioral control (PBC) is an individual's perception of the degree of control for performing a behavior [5]. PBC depends on how many resources and opportunities are required to be possessed by individuals when performing a behavior, such as money, time, and other resources. Individuals' confidence in being capable of performing a behavior is a determinant of PBC as well [5, 27]. A study developed a TPB research model for providing advice and guidance to pregnant women, which showed the contribution of PBC to predicting physical activity intention [28]. In addition, a recent study also found that an individual's perceived behavioral control toward health is significantly and positively associated with physical activity intention among older adults [29]. These

studies indicated the predictability of perceived behavioral control in different contexts. Furthermore, previous studies suggested that perceived behavioral control is a strong predictive factor in physical activity among people with kidney and colorectal cancer [30, 31]. People forming an intention precedes the development of a detailed plan and is facilitated by perceived control. Due to poorer health, people with long-term diseases have more difficulty engaging in physical activity than healthy people, whose behavioral intention might be mainly influenced by PBC. A recent study also supported that perceived behavioral control was the strongest predictor of intention to engage in physical activity via a survey of patients with coronary artery disease in Jordan, which suggested that the perceived capacity of being able to take part in physical activity is a crucial factor in promoting individuals' intention to practice physical activity [32].

Numerous studies have shown that the TPB is widely realized in physical activity. Hence, we propose the following hypotheses:

H1: Attitude toward regular physical activity is positively related to the intention to do regular physical activity.

H2: Subjective norms toward regular physical activity are positively related to the intention to partake in regular physical activity.

H3: Perceived behavioral control toward regular physical activity is positively related to the intention to practice regular physical activity.

2.2 The Moderating Roles of Subjective Health Knowledge and Education Level

Subjective health knowledge refers to how much individuals think they know [33], which represents the individual's cognitive level in their mind in regard to chronic diseases and physical activity. Compared with physical activity, subjective knowledge as a moderator is more common in consumption, pro-environmental behavior, and healthy eating in a TPB framework. However, the moderating effect of subjective health knowledge varies in different conditions and on distinctive variables. A study investigated the moderating role of subjective product knowledge and distinguished people's knowledge of convenience goods (such as fast food) and shopping goods (such as more carefully made food), which found that subjective knowledge of products weakened the relationship between subjective norms and the intention to make green purchases among convenience goods, while the relationship of attitude-intention and PBC-intention were impaired among shopping goods [34]. A previous study about healthy eating showed that the subjective knowledge of healthy eating moderated attitude-intention positively, but it induced the relationship of subjective norms-intention and PBC-intention more weakly among female adolescents [35]. Moreover, previous studies showed that subjective knowledge had no significant moderating effect on all TPB variables in different conditions. For instance, a study pointed out that subjective environmental knowledge strengthened the relationship between perceived behavioral control and the intention to sort household waste in China, which only moderated PBC-intention [36]. That subjective norms had no significant effect on the intention to sort household waste might be owing to the scanty experience of waste sorting among Chinese consumers. The result of an insignificant moderating effect between attitude and intention might be due to the attitude toward household waste sorting being established by limited knowledge of waste sorting in general to a certain extent. A study about organic food purchase intention in Tanzania

suggested that the subjective knowledge of organic food only enhanced the relationship of attitude-intention and subjective norms-intention [37]. There was no moderating effect of organic food knowledge on the PBC-intention relationship, perhaps because knowledge of organic food cannot influence the personal intention toward the purchase if they have already proposed to do so. Different contexts and subjects might give rise to different results. In terms of waste sorting in China, people with only a general knowledge of waste sorting needed to understand the specific method of sorting clearly before actual implementation, whereas knowledge of organic food in Tanzania mainly focused on the awareness that people just need to know about organic food, not implementation. Furthermore, the moderating role of subjective health knowledge of TPB in physical activity is not definite and clear, yet it is part of our knowledge. However, this is a prominent and still unrevealed ambiguous area to be investigated further.

Against this backdrop, the moderating effect of subjective health knowledge needs to be further investigated. This study aimed to research the moderating effect of subjective health knowledge on physical activity among individuals with chronic diseases. Based on this proposal, the following research questions were put forward:

RQ1: How does subjective health knowledge moderate the relationship between a person's attitude toward physical activity and their intention to participate in it?

RQ2: How does subjective health knowledge moderate the relationship between subjective norms toward physical activity and intention?

RQ3: How does subjective health knowledge moderate the relationship between perceived behavioral control over physical activity and the intention to participate in it?

A person's education level reflects their universal knowledge level and influences their values. People with a higher education level are more likely to have a broader horizon and think more in terms of the big picture. A person's education level affects their mindset and how they perceive and solve problems. Therefore, individuals with distinct education levels may have different intentions and perform diverse behaviors. The education level is expansively considered as a moderator in TPB. A study conducted two studies related to health cognitions of health behavior, which indicated that the education level positively moderated the attitude-intention relationship in both studies [11]. Moreover, highly educated individuals showed a stronger and positive relationship of subjective norms-intention toward health behavior in the latter study. A previous study investigating human development level revealed that people in highly developed countries tend to have a higher education level and a lower perceived behavioral control toward the consumption intention of green energy, which indicated that the education level played a negative moderating role in the PBC-intention relationship [38]. A study about the utility of mobile library apps found a significant difference in the relationship of attitude toward the utility of mobile phone apps and intention between undergraduate and graduate students in China, which suggested that education level enhanced the predictive ability of attitude to one's intention [10]. These studies indicated the different moderating effects of education level on TPB, while the moderating effects of the education level on physical activity are not yet clear. For this reason, we posed these research questions:

RQ4: How does education level moderate the relationship between a person's attitude toward physical activity and the intention to do it?

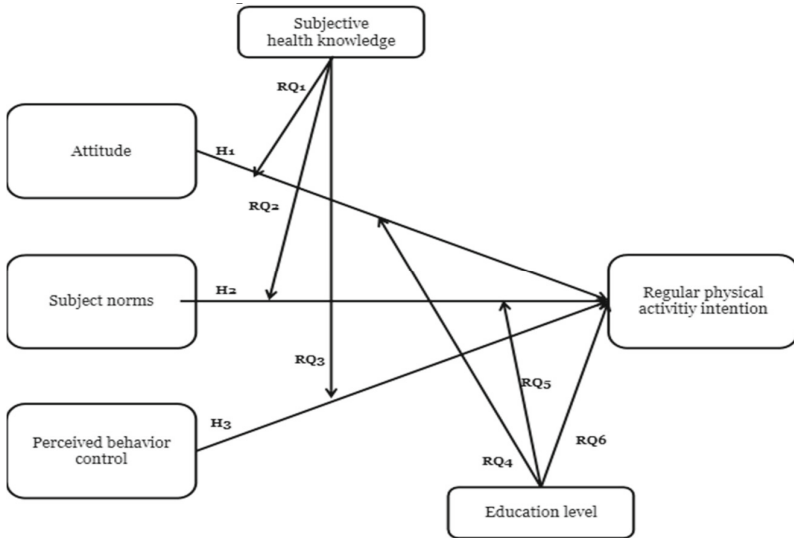


Fig. 1. Conceptual framework.

RQ5: How does education level moderate the relationship between subjective norms toward physical activity and the intention to participate?

RQ6: How does education level moderate the relationship between perceived behavioral control toward physical activity and the intention to exercise?

Figure 1 shows the research framework of this study.

3 Method

3.1 Data Collection

For this study, we conducted an online survey and disseminated the questionnaire link on WeChat from April 21, 2022, to April 28, 2022. The questionnaire was designed in English and translated into Chinese. To ensure the quality of the translation, the questionnaires were back-translated into English and checked against the English questionnaire. Fill-in time was about 2–4 min. The sampling strategy was convenient sampling and snowball sampling. A total of 679 respondents completed this survey and the number of valid respondents was 639 after excluding responses that were either too long or too brief.

3.2 Sample

Of the 639 respondents, 49.1% were male. Participants' ages ranged from 18 years to 84 years. Some 128 respondents were in the 18–40-year range, accounting for 20% of the sample; 311 respondents were 41–65 years old, accounting for 48.7% of the sample; and 200 respondents were over 65 years old, accounting for 31.3% of the total.

The mean age was 54.41 years ($SD = 15.80$). The median personal monthly income was RMB 3001–5000, with 146 respondents having an income lower than RMB 3000, accounting for 22.8%; 167 respondents earned RMB 3001–5000, accounting for 26.1%; 238 respondents made RMB 5001–10000, accounting for 37.2%; 66 respondents were in the RMB 10,000–20,000 range, accounting for 10.3%; and 22 respondents earned over RMB 20,000 accounting for 3.4%. The total valid number of respondents was 639. Of these, the median education level was senior high school. With 109 respondents having completed junior middle school or below, 55 respondents had studied in senior high school, 172 respondents had had a vocational education, 247 respondents had completed an undergraduate degree, and 56 respondents held a master's degree or above.

4 Measurements

4.1 Control Variables

Demographic variables were used to control variables in this study, including age, gender, education level, and personal monthly income.

4.2 Attitude Toward Regular Physical Activity

Attitude was measured on five dimensions adapted from Ajzen [39]. Respondents rated their attitude toward regular physical activity using the following descriptors: (a) beneficial, (b) pleasant, (c) worthwhile, (d) important, and (e) regular physical activity is compatible with my lifestyle. In this study, we used a 7-point Likert Scale (from 1 = strongly disagree to 7 = strongly agree) for each item ($M = 5.70$, $SD = 1.12$, Cronbach's $\alpha = 0.92$).

4.3 Subjective Norms

Subjective norms were measured using three items adapted from Ajzen and Driver [40], where respondents rated the following statements on a 7-point Likert Scale (from 1 = strongly disagree to 7 = strongly agree): (a) "Most people who are important to me think I exercise regularly"; (b) "People whose opinions I value think I exercise regularly"; (c) "People I consider as being important to me think I exercise regularly" ($M = 4.69$, $SD = 1.36$, Cronbach's $\alpha = 0.96$).

4.4 Perceived Behavioral Control Toward Regular Physical Activity

Perceived behavioral control was measured using four items adapted from Azjen [41]. Respondents rated the following statements on a 7-point Likert Scale (from 1 = strongly disagree to 7 = strongly agree): (a) "I can convince myself to take part in regular physical activity"; (b) "It is completely up to me whether I take part in regular physical activity or not"; (c) "I am confident that I can take part in regular physical activity"; (d) "If I wanted to, I could easily take part in regular physical activity" ($M = 4.93$, $SD = 1.27$, Cronbach's $\alpha = 0.91$).

4.5 Regular Physical Activity Intention

Behavior intention was measured on four items adapted from Ajzen (2002). Using a 7-point Likert Scale (from 1 = strongly disagree to 7 = strongly agree), respondents rated the following statements: (a) “I am motivated to take part in regular physical activity over the next month”; (b) “I strongly intend to do everything I can to take part in regular physical activity over the next month”; (c) “I plan to take part in regular physical activity over the next month”; (d) “I commit to taking part in regular physical activity over the next month” ($M = 4.54$, $SD = 1.13$, Cronbach’s $\alpha = 0.90$).

4.6 Subjective Health Knowledge

Subjective health knowledge was measured on three items adapted from Flynn and Goldsmith [42]. Using a 7-point Likert Scale (from 1 = strongly disagree to 7 = strongly agree), respondents rated the following statements: (a) “I know pretty much about health knowledge”; (b) “Among my circle of friends, I’m one of the ‘experts’ on health knowledge”; (c) “Compared to most other people, I know more about health knowledge” ($M = 5.10$, $SD = 1.53$, Cronbach’s $\alpha = 0.84$).

4.7 Education Level

Education level refers to a person’s highest level of education. In this study, we divided education into five levels, namely junior middle school or below, senior high school, vocational education, undergraduate degree, and master’s degree or above, based on the state of education in China. The median education level of our sample was a senior high school education, with 17.1% of the respondents educated to the junior middle school or below, 55 respondents (8.6%) finished the senior high school level, 172 respondents (26.9%) completed a vocational education, 247 respondents (38.7%) received an undergraduate degree, and 56 respondents (8.8%) had a master’s degree or above.

5 Results

5.1 Analysis Approach

Using SPSS version 26, a hierarchical regression analysis was conducted to test the hypotheses and research questions. The independent variables were put into the regression model according to their assumed casual order. The first block included age, gender, income, and education level as the demographic control variables. Attitude, subjective norms, and perceived behavioral control were entered in the second block. Next, we entered subjective knowledge in the third block. Last, subjective knowledge*TPB variables and education level*TPB variables were entered as interaction terms into the fourth block. The main effect variables were centered before the creation of interaction terms to prevent multicollinearity problems between the interaction terms and their components. In addition, the assumptions of regression were tested. First, all study variables were normally distributed. Second, according to the scatter plots, the relationship between the independent and dependent variables was linear. Lastly, there was no multicollinearity in the data, since the variance inflation factors (VIFs) for all dependent variables were smaller than 4.60.

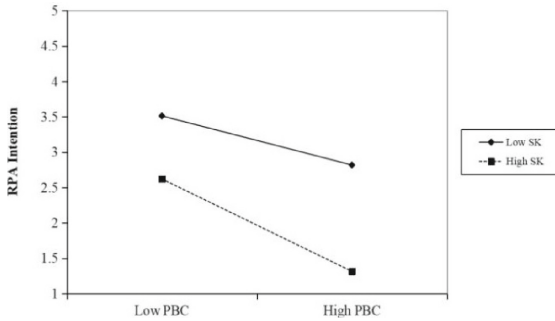


Fig. 2. The moderating role of subjective knowledge on the relationship between PBC and intention.

5.2 Hypothesis Test

The regression model explained a total of 67.2% of the variance in regular physical activity. First, the demographic variables in the first block explained 3.0% of the variance in regular physical activity. Specifically, age ($\beta = -0.15$, $p = 0.001$) was negatively related to regular physical activity. Concerning TPB, the results demonstrated that attitude ($\beta = 0.06$, $p > 0.05$) had no relation to the intention of regular physical activity, which rejected H1, while subjective norms ($\beta = 0.15$, $p < 0.001$) and perceived behavioral control ($\beta = 0.68$, $p < 0.001$) were positively related to the intention of regular physical activity, which supported H2 and H3.

To investigate the role of health knowledge, we set subjective health knowledge as a moderator. Subjective health knowledge negatively moderated the relationship between perceived behavioral control and the intention of regular physical activity ($\beta = -0.11$, $p < 0.05$) while having no moderating effect on the relationship between attitude ($\beta = 0.01$, $p > 0.05$), as well as subjective norms ($\beta = 0.06$, $p > 0.05$), and the intention of regular physical activity. RQs1–3 were answered. Education level negatively moderated the subjective norms-intention relationship ($\beta = -0.22$, $p < 0.05$), while having no moderating effect on attitude-intention ($\beta = 0.08$, $p > 0.05$) and PBC-intention relationship ($\beta = 0.10$, $p > 0.05$), thus answering RQs4–6. Table 1 showed Pearson correlations among all study variables (Figs. 2 and 3).

6 Discussion

This study aimed to explore the factors related to the intention to engage in regular physical activity among individuals with chronic diseases based on the theory of planned behavior. The moderating effects of subjective health knowledge and education level on the TPB were investigated as well.

The results showed that individuals with higher subjective norms and perceived behavioral control had higher intentions to engage in regular physical activity, with perceived behavioral control having the strongest effect on intention. This result was consistent with previous studies [7, 32]. Perceived behavioral control reflects the level of individuals' ability to control behaviors in their minds. A previous study pointed out

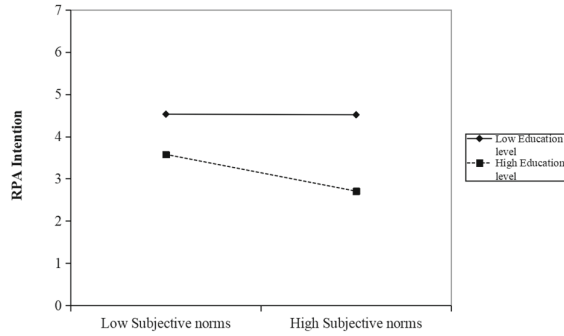


Fig. 3. The moderating role of education level on the relationship between subjective norms and intention.

Table 1. Pearson correlations among all study variables (n = 639).

	1	2	3	4	5	6	7	8
Age	1							
Gender	0.10*	1						
Education	0.45***	-0.07	1					
4. Income	-0.00	-0.28***	0.39***	1				
5. Attitude	-0.12**	-0.02	-0.02	0.06	1			
6. Subjective norms	-0.20***	-0.08*	-0.09*	0.05	0.63***	1		
7. Perceived behavioral control	-0.20***	-0.01*	-0.06	0.03	0.66***	0.78***	1	
8. Behavioral intention	-0.16***	-0.09*	-0.07	-0.00	0.59***	0.71***	0.83***	1

Note *p < 0.05, **p < 0.01, ***p < 0.001

that perceived control exists based on the perceived difficulty of behaviors in one’s early experiences [43]. The intention to perform physical activity is based on the perception of a person’s capability to do physical activity. Although people with chronic diseases tend to distance themselves from physical activity due to their physical limitations and related obstacles, they would like to engage in regular physical activity as much as possible. Therefore, it is reasonable that perceived behavioral control is the strongest predictor of the intention to partake in regular physical activity among people with chronic diseases in this study.

Contrary to our expectations, the attitude toward regular physical activity had no significant relation to the person’s intentions. This result might be due to the particularity of chronically ill patients, who most likely will be taking medicine regularly to mitigate their disease and promote health instead of relying on regular physical activity. Ajzen

Table 2. Hierarchical regression analysis predicting regular physical activity intention.

	Model 1	Model 2	Model 3	Model 4
Block 1:				
Age	-0.15**			
Gender	0.08			
Education level	0.01			
Income	-0.03			
R ² change	0.03			
Block 2:				
Attitude		0.06		
Subjective norms		0.15***		
Perceived behavior control		0.68***		
R ² change		0.67		
Block 3:				
Subjective knowledge			-0.01	
R ² change			0.00	
Block 4:				
Subjective knowledge * Attitude				0.01
Subjective knowledge * Subjective norms				0.06
Subjective knowledge * PBC				-0.11*
Education level * Attitude				0.08
Education level * Subjective norms				-0.22*
Education level * PBC				0.10
R ² change				0.01

Note *p < 0.05, **p < 0.01, ***p < 0.01

pointed out that attitude can have no relationship with intention in a specific behavioral context, which required further investigation [44]. Even if chronic patients perceived the benefits of regular physical activity, they may select more effective and efficient methods than they thought (e.g., taking medicine, diet therapy, and so on), which led to the attitude toward regular physical activity that was not related to intention.

Subjective health knowledge refers to individuals' perceptions of their knowledge attainment, which negatively moderated the relationship of PBC-intention. This result was in line with a prior study [34]. One plausible explanation is that to a certain extent subjective health knowledge indicates an individual's degree of self-confidence about their chronic disease. They might believe that they can control their disease effectively without regular physical activity and that medical treatment is a better way to deal with a chronic disease. At the same time, they may be not aware of the importance of regular physical activity for health enhancement. Hence, this attitude contributed to the result

that chronic patients with more subjective health knowledge were more reluctant to partake in regular physical activity.

This study showed that education level negatively moderated the subjective norms-intention relationship, which was in alignment with the study by Rodríguez and Bolzmann [45], which found that people with a higher education level allot less importance to social pressure, for they can think rationally and have more self-confidence in their behavior. People with a higher education level are more likely to be rational and independent, and possess more critical thinking capabilities, tending to perform behaviors following their own will. They may possess a tendency to make their judgment about their chronic disease and promote health in a way they believe is right for themselves. Perhaps they doubt that regular physical activity has an effect on controlling chronic disease. It may also be the case that the perception of others' expectations toward the supposed benefit of regular physical activity would give rise to a repugnant reaction on their part, leading to a reduced intention to practice regular physical activity.

7 Implications and Limitations

This study examined the theory of planned behavior in the context of physical activity among people with chronic diseases and explored the moderating effect of subjective health knowledge and education level within the TPB construct. In this study, we introduced subjective health knowledge and education level as moderators in the context of physical activity among people with chronic diseases and found they had a negative moderating effect on subjective norms-intention and PBC-intention relationships, thus expanding the theoretical framework of the theory of planned behavior.

In practice, this study has made a few contributions as well. Results suggested that improving the perception of physical activity ability was one of the most effective methods of encouraging chronic patients to engage in regular physical activity. Health communicators need to attach great importance to enhancing chronic patients' self-confidence. However, the negative moderating effects of subjective health knowledge and education level reminded us that the critical factor of physical activity was the objective and correct cognition of chronic diseases and physical activity, which requires the tailoring of the medical treatment for chronic patients with different levels of subjective health knowledge and education. In addition, doctors and health educators need to attach importance to promoting health knowledge and ensure chronic patients possess accurate health knowledge. Government and public health institutions should build a platform of health knowledge communication to enhance health education and encourage people to engage in physical activity.

This study has certain limitations that should be addressed in future studies. The sampling was from mainly one region of the country, which may lead to regional limitations due to ignoring the distinct socioeconomic characteristics across the nation. The data were collected only once which may have led to errors in measurement and requiring the causality of variables to be investigated further. Instead of measuring the actual physical activity behavior, this study focused on the intention to practice physical activity, thus opening the door for discovering possible differences that might be present in participants' behavior. Moreover, this study simply examined subjective health knowledge.

Due to the distinctive effect of subjective and objective knowledge [46], the moderating effects of objective health knowledge need to be explored for the effects of distinctive knowledge that lacks proper attention. On a similar note, future studies can investigate the effects of other socioeconomic factors on the intention to take up physical activity among people with chronic diseases.

8 Conclusions

Overall, this study examined the theory of planned behavior in the context of physical activity among people with chronic diseases and explored the moderating effect of subjective health knowledge and education level within the whole model. The results showed that individuals with higher subjective norms and perceived behavioral control had higher intentions to engage in regular physical activity, and perceived behavioral control had the strongest effect on intention. In this study, we found subjective health knowledge and education level as moderators had a negative moderating effect on subjective norms-intention and PBC-intention relationships. This study suggested health communicators need to attach great importance to enhancing chronic patients' self-confidence and tailoring the medical treatment for chronic patients with different levels of subjective health knowledge and education. Health educators are expected to help chronic patients possess accurate health knowledge, thus encouraging people to engage in physical activity.

Acknowledgments. This study appreciated the efforts of the second affiliated hospital of Fujian University of Traditional Chinese Medicine. They contributed considerable energy and time during data collection; without their help, this meaningful research could not have been completed.

Authors' contributions. Y.W. contributed to all the parts of this study.

References

1. World Health Organization, World health statistics 2021: monitoring health for the SDGs, sustainable development goals. Geneva: World Health Organization, 2021. [Online]. Available: <https://apps.who.int/iris/handle/10665/342703>
2. Chinese Center For Disease Control And Prevention, State report on nutrition and chronic diseases in Chinese residents 2020. People's Health Publishing House, 2022.
3. E. Anderson and J. L. Durstine, "Physical activity, exercise, and chronic diseases: A brief review", *Sports Medicine and Health Science*, vol. 1, no. 1, pp. 3–10, 2019.
4. General Administration of Sport of China, 2020 National Fitness Survey Communique, 2021. [Online]. Available: <https://www.sport.gov.cn/n20001280/n20001265/n20067533/c23881540/content.html>
5. I. Ajzen, "The theory of planned behavior", *Organizational Behavior and Human Decision Processes*, vol.50, no. 2, pp. 179–211, 1991.
6. A. Fattahi, R. Nikanjam, M. Barati, and A. Moghimbeigi, "Predictors of Physical Activity in Type 2 Diabetic Patients Based on the Theory of Planned Behavior", *Iranian Journal of Diabetes and Obesity*, vol. 11, 2020, DOI: <https://doi.org/10.18502/ijdo.v11i4.2878>.

7. F. Goldoust, G. Garmaroudi, M. Abolhasani, E. Shakibazadeh, and M. Yaseri, "Determinants of physical activity in women with multiple sclerosis based on theory of planned behavior", *Journal of Family Medicine and Primary Care*, vol. 11, no. 3, pp. 1077–1082, 2022, DOI: https://doi.org/10.4103/jfmpc.jfmpc_461_21.
8. P. D. O'Halloran et al., "Motivational interviewing to increase physical activity in people with chronic health conditions: a systematic review and meta-analysis", *Clinical Rehabilitation*, vol. 28, no. 12, pp. 1159–1171, 2014, DOI: <https://doi.org/10.1177/0269215514536210>.
9. S. Holdsworth, O. Sandri, I. Thomas, P. Wong, A. Chester, and P. McLaughlin, "The assessment of graduate sustainability attributes in the workplace: Potential advantages of using the theory of planned behavior (TPB)", *Journal of Cleaner Production*, vol. 238, pp. 117–929, 2019, DOI: <https://doi.org/10.1016/j.jclepro.2019.117929>.
10. J. Hu and Y. Zhang, "Chinese students' behavior intention to use mobile library apps and effects of education level and discipline", *Library Hi Tech*, vol. 34, no. 4, pp. 639–656, 2016, DOI: <https://doi.org/10.1108/LHT-06-2016-0061>.
11. B. Schüz, C. Brick, S. Wilding, and M. Conner, "Socioeconomic Status Moderates the Effects of Health Cognitions on Health Behaviors within Participants: Two Multibehavior Studies", *Annals of Behavioral Medicine*, vol. 54, no. 1, pp. 36–48, 2020, DOI: <https://doi.org/10.1093/abm/kaz023>.
12. M. W. Wibowo, A. L. S. Putri, A. Hanafiah, D. Permana, and F. Sh Ahmad, "How education level polarizes halal food purchase decision of Indonesian millennials", *Journal of Islamic Marketing*, 2021, DOI: <https://doi.org/10.1108/JIMA-10-2020-0323>.
13. I. Ajzen, "From intentions to actions: A theory of planned behavior", in *Action Control*, Springer, Berlin, Heidelberg, 1985, pp. 11–39.
14. R. Hirschey et al., "Predicting physical activity among cancer survivors: Meta-analytic path modeling of longitudinal studies", *Health Psychology*, vol. 39, no. 4, p. 269, 2020.
15. M. H. Sur, J. Jung, and D. R. Shapiro, "Theory of planned behavior to promote physical activity of adults with physical disabilities: Meta-analytic structural equation modeling", *Disability and Health Journal*, vol. 15, no. 1, pp. 101–199, 2022.
16. J. M. Brooks et al., "Towards an integration of the health promotion models of self-determination theory and the theory of planned behavior among people with chronic pain", *Rehabilitation Psychology*, vol. 63, no. 4, pp. 553–562, 2018, DOI: <https://doi.org/10.1037/rep0000245>.
17. M. Gao, X. Chen, X. Sun, F. Wang, L. Fan, and X. Sun, "Predicting stage of exercise among patients with type 2 diabetes: A test of the extended theory of planned behavior", *Patient Prefer Adherence*, vol. 14, pp. 277–285, 2020, DOI: <https://doi.org/10.2147/PPA.S236813>.
18. H. Sanaeinasab et al., "A theory of planned behavior-based program to increase physical activity in overweight/obese military personnel: A randomised controlled trial", *Applied Psychology: Health and Well-Being*, vol. 12, no. 1, pp. 101–124, 2020.
19. I. Ajzen and M. Fishbein, "Attitudes and the attitude-behavior relation: Reasoned and automatic processes", *European review of social psychology*, vol. 11, no. 1, pp. 1–33, 2000.
20. G. Chevance, J. Caudroit, T. Henry, P. Guerin, J. Boiché, and N. Héraud, "Do implicit attitudes toward physical activity and sedentary behavior prospectively predict objective physical activity among persons with obesity", *J Behav Med*, vol. 41, no. 1, pp. 31–42, 2018, DOI: <https://doi.org/10.1007/s10865-017-9881-8>.
21. E. Hatefnia, K. Alizadeh, and M. Ghorbani, "Applying the theory of planned behavior to determine factors associated with physical activity by women with hypertension in rural areas of Iran", *Asian Biomedicine*, vol. 12, no. 2, pp. 83–90, 2018, DOI: <https://doi.org/10.1515/abm-2019-0005>.
22. T. Liao, S. Tang, and Y. Shim, "The Development of a Model to Predict Sports Participation among College Students in Central China", *International Journal of Environmental Research and Public Health*, vol. 19, no. 3, p. 1806, 2022, DOI: <https://doi.org/10.3390/ijerph19031806>.

23. L. Moutinho, R. Ballantyne, and S. Rate, "Consumer Behaviour in Tourism", p. 83, 2011.
24. A. J. Crozier, M. A. Carmichael, J. R. Townsend, J. M. Bingham, and B. J. Stenner, "Norms in sport: a scoping review", *International Review of Sport and Exercise Psychology*, vol. 12, pp. 1–23, 2022, DOI: <https://doi.org/10.1080/1750984X.2022.2051151>.
25. J. Kim, E. Dunn, K. Rellinger, J. Robertson-Wilson, and M. Eys, "Social norms and physical activity in American and Canadian contexts: a scoping review", *International Review of Sport and Exercise Psychology*, vol. 12, no. 1, pp. 26–48, 2019, DOI: <https://doi.org/10.1080/1750984X.2017.1354229>.
26. J. Úbeda-Colomer, K. A. Martin Ginis, J. Monforte, V. Pérez-Samaniego, and J. Devís-Devís, "Predicting physical activity in university students with disabilities: The role of social ecological barriers in the theory of planned behaviour", *Disability and Health Journal*, vol. 12, no. 4, pp. 574–580, 2019, DOI: <https://doi.org/10.1016/j.dhjo.2019.06.008>.
27. I. Ajzen and T. J. Madden, "Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control", *Journal of experimental social psychology*, vol. 22, no. 5, pp. 453–474, 1986.
28. M. De Vivo and H. Mills, "Laying the Foundation for Pregnancy Physical Activity Profiling: A Framework for Providing Tailored Physical Activity Advice and Guidance to Pregnant Women", *International Journal of Environmental Research and Public Health*, vol. 18, no. 11, 2021, DOI: <https://doi.org/10.3390/ijerph18115996>.
29. K. A. Caillouet and L. Cosio-Lima, "Association of health empowerment and handgrip strength with intention to participate in physical activity among community-dwelling older adults", *Experimental Gerontology*, vol. 121, pp. 99–105, 2019, DOI: <https://doi.org/10.1016/j.exger.2019.04.001>.
30. A. E. Speed-Andrews et al., "Medical, demographic and social cognitive correlates of physical activity in a population-based sample of colorectal cancer survivors", *European Journal of Cancer Care*, vol. 21, no. 2, pp. 187–196, 2012, DOI: <https://doi.org/10.1111/j.1365-2354.2011.01290.x>.
31. L. Trinh, R. C. Plotnikoff, R. E. Rhodes, S. North, and K. S. Courneya, "Correlates of physical activity in a population-based sample of kidney cancer survivors: an application of the theory of planned behavior", *International Journal of Behavioral Nutrition and Physical Activity*, vol. 9, no. 1, p. 96, 2012, DOI: <https://doi.org/10.1186/1479-5868-9-96>.
32. S. Kanan, G. Shahrou, B. Broome, D. Bernert, M. Alibrahim, and D. Hansen, "Predicting intentions of physical activity in patients with coronary artery disease: attitudes, subjective norms and perceived behavioral control", *British Journal of Cardiac Nursing*, vol. 16, no. 1, pp. 1–9, 2021, DOI: <https://doi.org/10.12968/bjca.2020.0068>.
33. T. Pucci, E. Casprini, C. Nosi, and L. Zanni, "Does social media usage affect online purchasing intention for wine? The moderating role of subjective and objective knowledge", *British Food Journal*, vol. 121, no. 2, pp. 275–288, 2019, DOI: <https://doi.org/10.1108/BFJ-06-2018-0400>.
34. K. Chen and T. Deng, "Research on the Green Purchase Intentions from the Perspective of Product Knowledge", *Sustainability*, vol. 8, no. 9, 2016, DOI: <https://doi.org/10.3390/su8090943>.
35. F. U. Syed, B. Abbass, M. Rizwan, M. Baloch, and D. K. Mehmood, "Subjective knowledge and the antecedent-mediator relationship of TPB in female adolescence: healthy eating intentions prediction", *Reviews of Management Sciences*, vol. 3, no. 2, 2021, DOI: <https://doi.org/10.53909/admin.v3i2.101>.
36. Y. Wang, X. Long, L. Li, Q. Wang, X. Ding, and S. Cai, "Extending theory of planned behavior in household waste sorting in China: the moderating effect of knowledge, personal involvement, and moral responsibility", *Environment, Development and Sustainability*, vol. 23, no. 5, pp. 7230–7250, 2021, DOI: <https://doi.org/10.1007/s10668-020-00913-9>.

37. X. Wang, F. Pacho, J. Liu, and R. Kajungiro, "Factors influencing organic food purchase intention in developing countries and the moderating role of knowledge", *Sustainability*, vol. 11, no. 1, 2019, DOI: <https://doi.org/10.3390/su11010209>.
38. G. Kumar and J. K. Nayak, "A meta-analysis of TPB model in predicting green energy behavior: The moderating role of cross-cultural factors", *Journal of International Consumer Marketing*, pp. 1–19, 2022, DOI: <https://doi.org/10.1080/08961530.2022.2070900>.
39. I. Ajzen, "Constructing a TPB questionnaire: Conceptual and methodological considerations", 2002.
40. I. Ajzen and B. L. Driver, "Prediction of Leisure Participation from Behavioral, Normative, and Control Beliefs: An Application of the Theory of Planned Behavior", *Leisure Sciences*, vol. 13, pp. 185–204, 1991, DOI: <https://doi.org/10.1080/01490409109513137>.
41. I. Ajzen, "Residual Effects of Past on Later Behavior: Habituation and Reasoned Action Perspectives", *Personality and Social Psychology Review*, vol. 6, pp. 107–122, 2002, DOI: https://doi.org/10.1207/S15327957PSPR0602_02.
42. L. R. Flynn and R. E. Goldsmith, "A short, reliable measure of subjective knowledge", *Journal of Business Research*, vol. 46, no. 1, pp. 57–66, 1999, DOI: [https://doi.org/10.1016/S0148-2963\(98\)00057-5](https://doi.org/10.1016/S0148-2963(98)00057-5).
43. S. E. Linke, C. J. Robinson, and D. Pekmezi, "Applying psychological theories to promote healthy lifestyles", *American Journal of Lifestyle Medicine*, vol. 8, no. 1, pp. 4–14, 2014.
44. I. Ajzen, "The theory of planned behaviour: Reactions and reflections", *Psychology & Health*, vol. 26, no. 9, pp. 1113–1127, 2011.
45. I. E. Aguilar-Rodríguez and L. G. Arias-Bolzmann, "Lifestyle and purchase intention: The moderating role of education in bicultural consumers", *Journal of International Consumer Marketing*, pp. 1–17, 2021, DOI: <https://doi.org/10.1080/08961530.2021.2020702>.
46. P. S. Raju, S. C. Lonial, and W. G. Mangold, "Differential effects of subjective knowledge, objective knowledge, and usage experience on decision making: An exploratory investigation", *Journal of Consumer Psychology*, vol. 4, no. 2, pp. 153–180, 1995.

Open Access This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

